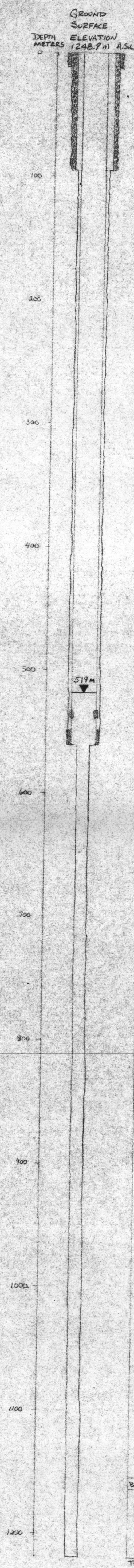
DRILL HOLE DATA USW H-4

DEPTH METERS — GROUND SURFACE ELEVATION 1248.9 m A.S.L.



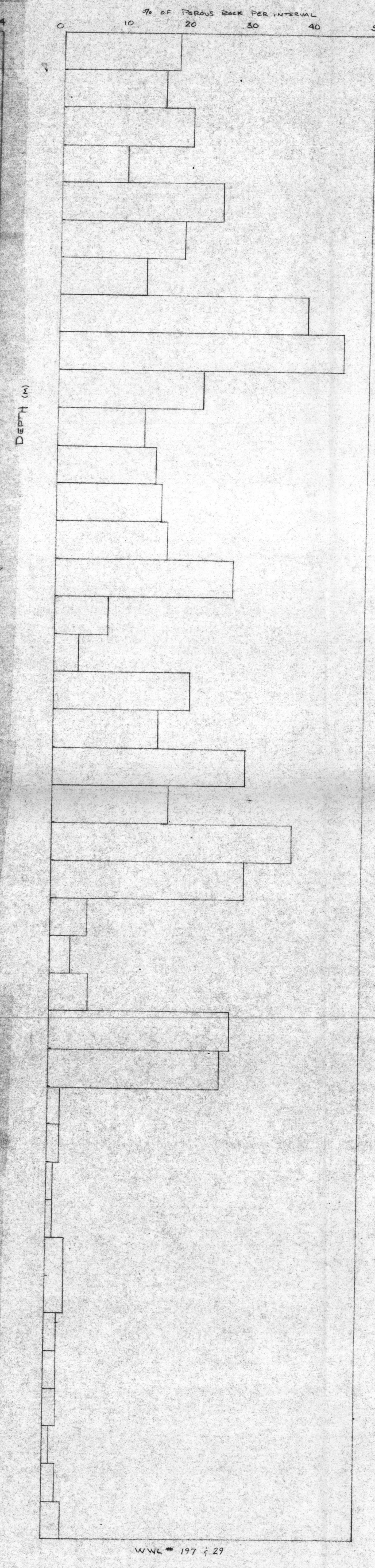
STRATIGRAPHIC UNIT	LITHOLOGIC DESCRIPTION
TIVA CANYON MEMBER	TUFF, ASH FLOW, MEDIUM-GRAY TO MEDIUM-LIGHT-GRAY, DENSELY WELDED, DEVITRIFIED; PUMICE, LIGHT GRAY, VERY LIGHT-GRAY; LESS THAN 2% PHENOCRYSTS; RARE VOLCANIC LITHIC FRAGMENTS; MAY CORRELATE WITH "LOWER LITHOPHYSAL UNIT"
	TUFF, ASH FLOW, DARK-YELLOWISH BROWN AND BROWNISH-GRAY, DENSELY WELDED, DEVITRIFIED; PUMICE, DARK-YELLOWISH BROWN; LESS THAN 2% PHENOCRYSTS; RARE DARK-REDDISH-BROWN AND GRAYISH-RED VOLCANIC LITHIC FRAGMENTS.
	TUFF, ASH FLOW: PALE-BROWN AND DARK-YELLOWISH-BROWN, DEVITRIFIED; PUMICE, MODERATE-REDDISH-ORANGE DEVITRIFIED (OCCASIONALLY PUMICE FRAGMENTS ALTERED TO CLAY); 1-2% PHENOCRYSTS; RARE GRAYISH-RED VOLCANIC LITHIC FRAGMENTS.
	TUFF, ASH FLOW, PARTIALLY TO NONWELDED, VITRIC; PUMICE, PALE-YELLOWISH-ORANGE, VITRIC; 1% PHENOCRYSTS (SANIDINE AND PLAGIOCLASE, RARE BIOTITE); RARE LIGHT GRAY RHYOLITIC LITHIC FRAGMENTS; ABUNDANT DARK-YELLOWISH-ORANGE AND BLACK GLASS SHARDS
	TUFF, BEDDED, REWORKED, VITRIC
TOPOPAH SPRING MEMBER	TUFF, ASH-FLOW (?): TUFF, ASH FLOW, MODERATE-REDDISH-ORANGE AND MODERATE-RED, NONWELDED, VITRIC; ABUNDANT GRAYISH-ORANGE, LIGHT BROWN, AND MODERATE-RED, VITRIC PUMICE; 3-4% PHENOCRYSTS (SANIDINE, PLAGIOCLASE AND BRONZE BIOTITE)
	PARTLY TO MODERATELY WELDED, VERY LIGHT GRAY, VITRIC [LOWER 0.3-0.6 m PALE-REDDISH-BROWN VITROPHYRE]
	TUFF ASH-FLOW: TUFF, ASH-FLOW, BROWNISH-GRAY, DENSELY WELDED, DEVITRIFIED; PUMICE, BROWNISH GRAY, DEVITRIFIED; 10% PHENOCRYSTS (SANIDINE, PLAGIOCLASE, AND BRONZE BIOTITE); CAPROCK
	PALE-RED AND GRAYISH-RED, MODERATELY WELDED, VAPOR PHASE CRYSTALLIZATION; PUMICE, COMMONLY PALE-RED AND LIGHT-BROWNISH GRAY, VAPOR-PHASE; 5-7% PHENOCRYSTS (SANIDINE, PLAGIOCLASE, AND BRONZE BIOTITE)
	TUFF, ASH-FLOW, LIGHT-GRAY AND LIGHT-BROWNISH-GRAY, DENSELY WELDED, DEVITRIFIED, LITHOPHYSAL ZONE (?); PUMICE LIGHT-GRAY, VERY LIGHT GRAY, AND LIGHT-BROWNISH GRAY, DEVITRIFIED; 3-4% PHENOCRYSTS (SANIDINE, PLAGIOCLASE, AND RARE BIOTITE); SIZE OF BIT CUTTINGS DECREASE CONSPICUOUSLY BELOW 155.4 m.
	TUFF, ASH-FLOW, BROWNISH-GRAY, LIGHT-BROWN, AND MODERATE-BROWN, DENSELY WELDED, DEVITRIFIED; PUMICE, BROWNISH-GRAY AND MODERATE-BROWN, DEVITRIFIED; LESS THAN 1% PHENOCRYSTS (SANIDINE AND PLAGIOCLASE); TELEVISION CAMERA INDICATES A LITHOPHYSAL ZONE FROM 215.8 TO 305.7 m. WITHIN ZONE, BIT CUTTINGS ARE RELATIVELY LARGER AND MOTTLED.
	TUFF, ASH-FLOW, BLACK, GLASSY VITROPHYRE
	TUFF, ASH FLOW, PALE-YELLOWISH-ORANGE, PARTLY WELDED, VITRIC; CONTAINS ABUNDANT BLACK GLASS SHARDS
	TUFF, ASH FLOW, PINKISH-GRAY, AND YELLOWISH-GRAY, NONWELDED (FRIABLE), VITRIC [SLIGHTLY ARGILLIC (?)]; PUMICE, GRAYISH-PINK, VITRIC AND ARGILLIC; ABUNDANT BLACK GLASS SHARDS; INTERVAL FROM 393.8 TO BASE CONTAINS ABUNDANT LARGE LITHIC FRAGMENTS; NO BEDDED INTERVAL RECOGNIZED AT BASE OF INTERVAL.
TUFFACEOUS BEDS OF CALICO HILLS	TUFF, ASH FLOW, MODERATE-ORANGE-PINK, VERY PALE ORANGE, AND GRAYISH YELLOW, NONWELDED TO PARTLY WELDED, DEVITRIFIED AND ZEOLITIZED (?); UPPER 11 m SILICIFIED (?); PUMICE, WHITE, PINK, AND GRAYISH-YELLOW, ZEOLITIZED (?); LESS THAN 1% PHENOCRYSTS (QUARTZ AND BIOTITE); ABUNDANT LIGHT-GRAY AND MEDIUM-LIGHT-GRAY, AND GRAYISH-RED RHYOLITIC LITHIC FRAGMENTS. SIDE-WALL SAMPLES COLLECTED AT 399.9, 422.8, 442.9, AND 472.4 m; ALL SIDEWALL SAMPLES VARY IN COLOR; ALL SAMPLES ARE NON-WELDED, ZEOLITIZED (?), AND PARTLY SILICIFIED; SAMPLE AT 432.8 m INDICATES A DECREASE IN DEGREE OF SILICIFICATION.
	TUFF, BEDDED, REWORKED, YELLOWISH-GRAY, PALE-REDDISH-BROWN, GRAYISH-YELLOW, DEVITRIFIED AND ZEOLITIZED (?); LOWER 4.6 m, PALE-RED, HIGHLY SILICIFIED.
PROW PASS MEMBER	TUFF, ASH FLOW: GRAYISH-YELLOW, NONWELDED, ZEOLITIC; PUMICE, GRAYISH-YELLOW, ZEOLITIC; 10% PHENOCRYSTS OF QUARTZ, SANIDINE, AND BIOTITE
	TUFF, ASH FLOW: PALE REDDISH-BROWN, PARTLY WELDED, DEVITRIFIED (SOME VAPOR PHASE PUMICE); APPEARS MODERATELY SILICIFIED; 7-8% PHENOCRYSTS (QUARTZ, SANIDINE, BIOTITE); RARE PALE-REDDISH BROWN MUDSTONE LITHIC FRAGMENTS; SIDEWALL SAMPLE COLLECTED 504.7 m IS LIGHT OLIVE-GRAY, PARTLY WELDED, DEVITRIFIED (VAPOR PHASE CRYSTALLIZATION); PUMICE, LIGHT-BROWN, VAPOR PHASE; 5% PHENOCRYSTS (QUARTZ, SANIDINE, PLAGIOCLASE); RARE MUDSTONE LITHIC FRAGMENTS.
	TUFF, ASH FLOW: YELLOWISH-GRAY, LIGHT GRAY, AND MEDIUM-LIGHT-GRAY PARTIALLY WELDED, DEVITRIFIED; PUMICE, LIGHT-GRAY DEVITRIFIED, WHITE TO MODERATE-ORANGE-PINK AND SLIGHTLY ZEOLITIC (?) FROM 536.4 m TO BASE; 5-10% PHENOCRYSTS [QUARTZ, PLAGIOCLASE, SANIDINE, BIOTITE, AND PYROXENE (?)]; SPARSE MODERATE-REDDISH-BROWN MUDSTONE LITHIC FRAGMENTS; CONTAMINATED SAMPLES FROM 539.5 TO 573.0 m.
	TUFF, ASH-FLOW, DUSKY-YELLOW, PARTLY WELDED, HIGHLY ZEOLITIC (?) AND SILICIFIED; PUMICE DUSKY-YELLOW, ZEOLITIZED (?) AND SILICIFIED; 10% PHENOCRYSTS (QUARTZ, SANIDINE, PLAGIOCLASE, AND BIOTITE); SPARSE MODERATE-REDDISH-BROWN MUDSTONE LITHIC FRAGMENTS
	TUFF, ASH FLOW, YELLOWISH-GRAY, MODERATE-ORANGE-PINK, AND DUSKY-YELLOW, PARTLY WELDED, ZEOLITIC AND VITRIC (?) [APPEARS ONLY SLIGHTLY ZEOLITIZED (?)]; PUMICE, WHITE, PALE-GREENISH-YELLOW, AND DUSKY-YELLOW, ZEOLITIC AND VITRIC (?); 10% PHENOCRYSTS (QUARTZ, SANIDINE, PLAGIOCLASE, AND BIOTITE); SPARSE MODERATE-REDDISH-BROWN MUDSTONE LITHIC FRAGMENTS; X-RAY ANALYSIS OF BIT CUTTINGS INDICATES THE PRESENCE OF CLINOPTILOLITE AND MORDENITE (ESTIMATED AT 50%)
BEDDED TUFF	TUFF, BEDDED, REWORKED, LIGHT-RED, MODERATE-REDDISH-ORANGE, ZEOLITIZED
BULLFROG MEMBER	TUFF, ASH-FLOW, MEDIUM-GRAY AND PALE-YELLOWISH-BROWN, PARTLY WELDED, DEVITRIFIED; PUMICE, VERY LIGHT GRAY TO LIGHT GRAY, DEVITRIFIED [VAPOR PHASE CRYSTALLIZATION (?)]; 15% PHENOCRYSTS (QUARTZ, SANIDINE, PLAGIOCLASES, AND BRONZE BIOTITE)
	TUFF, ASH FLOW, LIGHT-GRAY AND LIGHT-BROWNISH-GRAY, PARTLY WELDED, VAPOR-PHASE CRYSTALLIZATION (?); PUMICE, MEDIUM-LIGHT-GRAY, VAPOR PHASE; 10% PHENOCRYSTS (QUARTZ, PLAGIOCLASE, SANIDINE, AND BIOTITE).
	TUFF, ASH FLOW, LIGHT-BROWN, AND MODERATE-YELLOWISH-BROWN, MODERATE TO DENSELY WELDED, SLIGHTLY ALTERED TO ZEOLITES (?); PUMICE, LIGHT-BROWN, SILICIFIED (?); 5-7 PERCENT PHENOCRYSTS (QUARTZ, PLAGIOCLASE, SANIDINE, AND BIOTITE); RARE GRAYISH-RED VOLCANIC LITHIC FRAGMENTS; PUMICE FRAGMENTS ARE BLACK AND GLASSY FROM 765.0 TO 774.2 m.
	TUFF, ASH FLOW; GRAYISH-ORANGE-PINK AND LIGHT-BROWN, NONWELDED TO PARTLY WELDED, DEVITRIFIED; PUMICE, LIGHT-BROWN, DEVITRIFIED; 10% PHENOCRYSTS (QUARTZ, PLAGIOCLASE, SANIDINE, AND BIOTITE); RARE MEDIUM-LIGHT-GRAY VOLCANIC LITHIC FRAGMENTS; BIT CUTTING SAMPLES ARE CONTAMINATED FROM 792.5 TO 826.0 m.
BEDDED TUFF	TUFF, BEDDED, REWORKED, WHITE TO GRAYISH PINK, DEVITRIFIED
TRAM MEMBER	TUFF ASH-FLOW(?), PARTLY WELDED (?), DEVITRIFIED (?); THIS INTERVAL IS BASED ON GEOPHYSICAL CHARACTERISTICS CORRELATED WITH OTHER DRILL HOLES WHERE BOTH CORE AND GEOPHYSICAL LOGS EXIST. NOTE: SAMPLES ARE HIGHLY CONTAMINATED FROM 832.1 - 841.2 m, 844.3 - 847.3 m, 896.1 TO 902.2 m, AND DOMINATELY CONTAIN CUTTINGS FROM THE PROW PASS MEMBER; SAMPLES FROM 896.1 - 899.2 m AND 944.9 - 957.1 m DOMINATELY CONTAIN CUTTINGS FROM THE BULLFROG MEMBER; NO SAMPLES WERE COLLECTED FROM 902.2 TO 920.5 m.
	TUFF ASH-FLOW, LIGHT BROWNISH-GRAY AND LIGHT OLIVE-GRAY, MODERATELY WELDED, DEVITRIFIED; PUMICE, WHITE, LIGHT-GRAY TO LIGHT-BROWNISH-GRAY, DEVITRIFIED; 10% PHENOCRYSTS (QUARTZ, SANIDINE, PLAGIOCLASE, BLACK AND BRONZE BIOTITE); RARE LIGHT-BROWNISH-GRAY AND BROWNISH-GRAY SILICIC TO INTERMEDIATE VOLCANIC LITHIC FRAGMENTS; BASED ON A SIMILAR ELECTRIC LOG RESPONSE FOUND IN OTHER DRILL HOLES, THE INTERVAL FROM 917.4 TO 956.8 m PROBABLY IS HIGHLY ZEOLITIZED AND SILICIFIED
	TUFF, ASH-FLOW, LIGHT-GRAY, OLIVE-GRAY, AND LIGHT-BROWNISH-GRAY, PARTLY WELDED (?), DEVITRIFIED [SLIGHTLY ZEOLITIZED (?)]; PUMICE, LIGHT-GRAY TO BROWNISH-GRAY, ARGILLIC (?) AND ZEOLITIC (?); ABUNDANT BROWNISH-GRAY AND LIGHT-GRAY SILICIC TO INTERMEDIATE LITHIC FRAGMENTS
	TUFF, ASH-FLOW, GRAYISH-YELLOWISH-GREEN, LIGHT-GRAY, LIGHT-GREENISH GRAY, MODERATE-YELLOW-GREEN, AND GREENISH-GRAY, PARTLY WELDED (?), ZEOLITIC (?); PUMICE, LIGHT-GREENISH-GRAY AND LIGHT GRAY, ZEOLITIC (?), ARGILLIC (?); ABUNDANT MED.-LIGHT GRAY AND BROWNISH-GRAY VOLCANIC LITHIC FRAGMENTS; RARE PYRITE (?) PRESENT IN LITHIC FRAGMENTS AND OCCASIONALLY IN GROUNDMASS.
BEDDED TUFF	TUFF, BEDDED, REWORKED, DARK-GREENISH-GRAY, GREENISH-GRAY, GRAYISH-YELLOW-GREEN, ZEOLITIC (?); ABUNDANT ZEOLITIC (?) PUMICE, SPARSE LITHIC FRAGMENTS, RARE BIOTITE.
LITHIC RIDGE TUFF	TUFF, ASH-FLOW, GRAYISH-ORANGE, MODERATE YELLOWISH-BRN., PARTLY WELDED, DEVITRIFIED; PUMICE, WHITE, GRAYISH-ORANGE, DEVITRIFIED; 5% PHENOCRYSTS (QUARTZ, SANIDINE, PLAGIOCLASE, AND ABUNDANT BLACK BIOTITE); SPARSE LITHIC FRAGMENTS; SAMPLES HIGHLY CONTAMINATED BELOW 1,182.6 m

TOTAL DEPTH 1219.2 m

CUMULATIVE DRILLING FLUID USE[1]

PERCENTAGE OF POROUS ROCK[2]

(PER INTERVAL GREATER THAN AVE. POROSITY)



NOTES ON TEST HOLE USW-H4

DRILLING FLUID: AIR FOAM, APPROX. 30,000 L OF DETERGENT & 3,150,000 OF WATER WERE USED
TOTAL DEPTH: 1219 M
GROUND SURFACE ELEV: 1248.9 M ABOVE SEA LEVEL
CASING PERFORATED FROM 533 m TO 539 m W/6 SHOTS PER METER
STATIC WATER LEVEL ~ 519 M DEPTH

1.) AT DEPTHS OF 55 & 536 M FLUID LOSS OCCURRED DURING LOGGING, WHEN NO DRILLING WAS IN PROGRESS

2.) THE ROCK SEQUENCE PENETRATED WAS DIVIDED INTO 40 EQUAL PARTS OF APPROX 30.5 m EACH. USING NEUTRON AND DENSITY LOGS, EACH DEPTH INTERVAL WAS EVALUATED FOR % OF RELATIVELY POROUS ROCK; THAT IS, ROCK HAVING POROSITY GREATER THAN THE AVERAGE FOR THE ROCK PENETRATED BY THE WELL. THIS GRAPH ONLY APPROXIMATES THE % OF ROCK WITH POROSITY GREATER THAN THE AVE., AND DOES NOT GIVE ABSOLUTE POROSITY VALUES. (WWL # 197 pg 16)

3.) RADIOACTIVE TRACER WAS USED TO MEASURE BOREHOLE FLOW RATE. A WATER TEMPERATURE PROFILE OF THE WELLBORE WAS ALSO RECORDED DURING THE FLOW SURVEY. THE SLOPE OF THE TEMPERATURE GRADIENT CURVE CLOSELY PARALLELED THE FLOW RATE CURVE. THE MOST PRODUCTIVE GEOLOGIC UNIT IS THE BULLFROG MEMBER, OTHER HIGH PERMEABILITY ZONES WERE THIN INTERVALS (<16 m) OCCURRING IN THE PROW PASS MEMBER, TRAM MEMBER, AND LITHIC RIDGE TUFF. THESE THIN, HIGH PERMEABILITY ZONES CAN BE RELATED TO EXTENSIVE FRACTURE SYSTEMS. (WWL # 197)

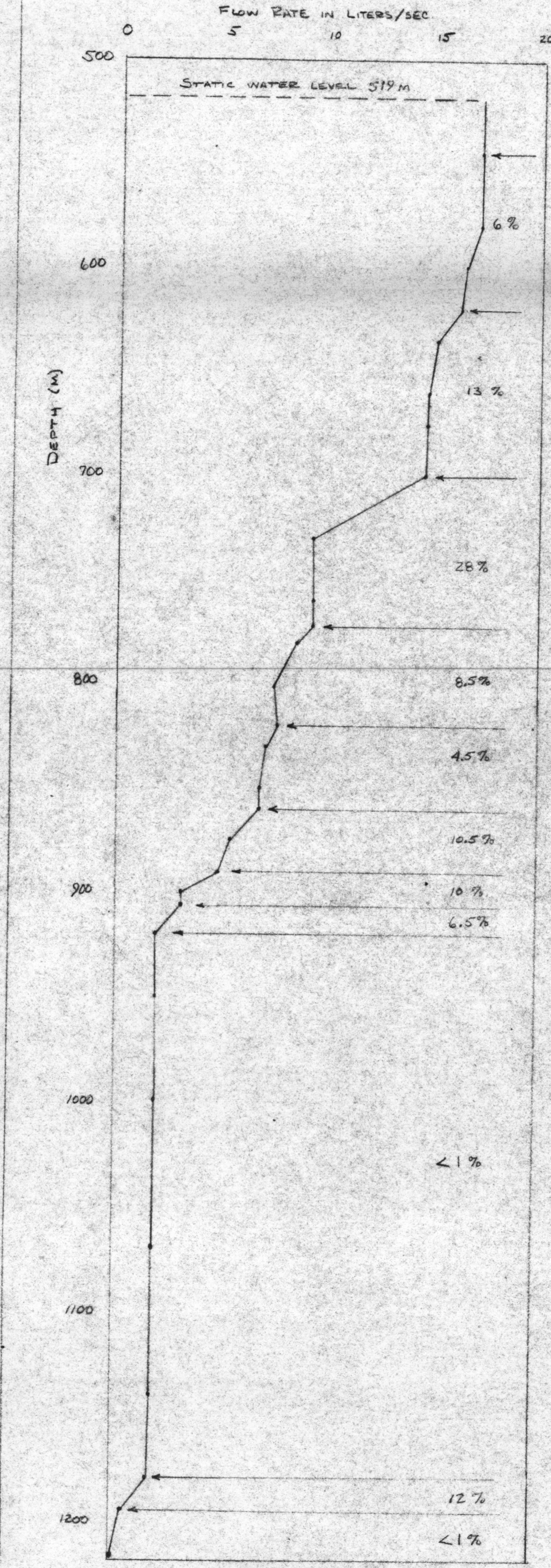
4.) FLOW POINTS IDENTIFIED HERE ARE FRACTURES THROUGH WHICH WATER ENTERS THE BOREHOLE. FLOW POINTS WERE LOCATED BY TEMPERATURE SURVEY. 33 SEPARATE INFLOW POINTS WERE IDENTIFIED, INTERVALS DEVOID OF DISTINCT INFLOW POINTS MAY HAVE WATER ENTERING FROM THE ROCK MATRIX BUT NOT FRACTURES. (WWL # 86 pg 8)

5.) HYDRAULIC INJECTION TESTING WAS PERFORMED IN INTERVALS ISOLATED BY PACKERS. THE ISOLATED TEST INTERVALS ARE SHOWN IN THE GRAPH. THE TIME REQUIRED FOR WATER LEVEL IN THE TUBING TO FALL TO THE PRETEST LEVEL IS SHOWN BESIDE THE INTERVAL (IN MINUTES). INTERVALS WHERE THE RECOVERY TIME IS 2.5 - 3.0 MIN. ARE QUITE PERMEABLE (WWL # 86 pg 12)

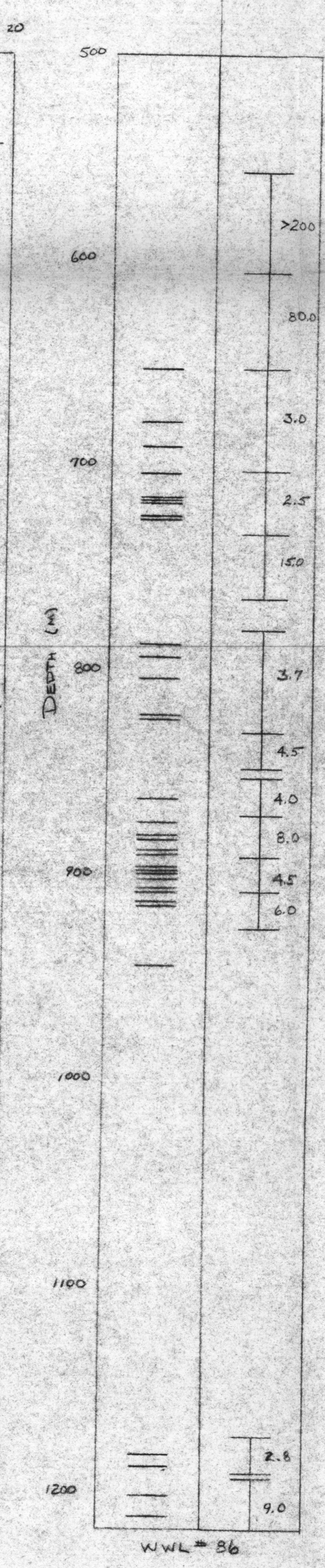
6.) VALUES OF APPARENT TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY WERE DETERMINED FOR THE PRODUCING INTERVALS IDENTIFIED IN THE PUMP TEST AND BOREHOLE FLOW SURVEY. HYDRAULIC COEFFICIENTS SHOWN IN THE GRAPH WERE COMPUTED BY PROPORTIONING THE TRANSMISSIVITY VALUES OBTAINED FROM THE PUMP TEST TO THE PRODUCTIVE ZONES AS DETERMINED BY THE BOREHOLE-FLOW SURVEY (WWL # 197 pg 28). TRANSMISSIVITY VALUES FOR THE ZONES IS LISTED AT RIGHT OF THE GRAPH IN M²/DAY.

BOREHOLE FLOW SURVEY[3]

SHOWING % OF PUMPING RATE PRODUCED BY INTERVALS

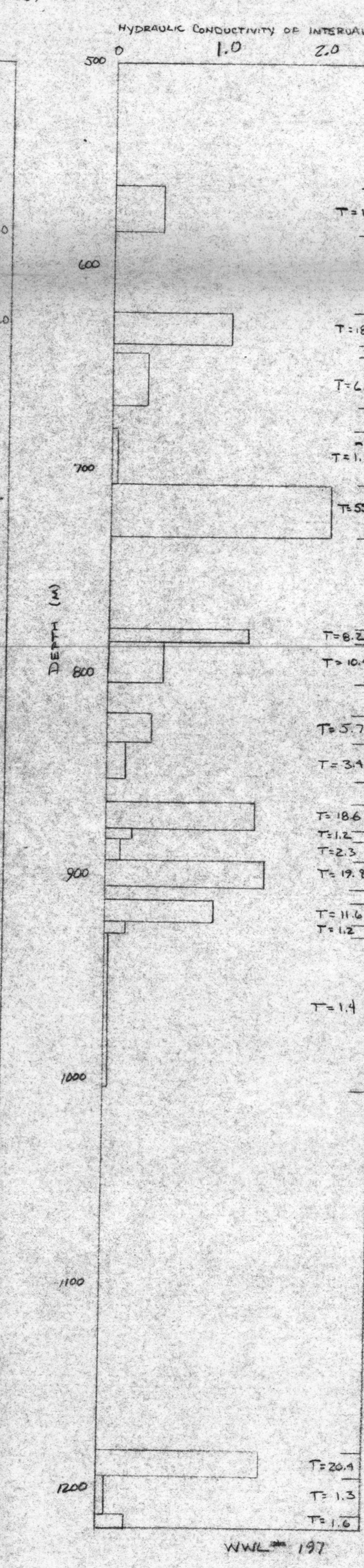


LOCATION OF FLOW POINTS[4] / INJECTION-TEST INTERVALS AND RECOVERY TIME (IN MINUTES)[5]



DISTRIBUTION OF HYDRAULIC CONDUCTIVITY[6]

(BASED ON PUMPING TEST AND RADIOACTIVE TRACER, BOREHOLE FLOW SURVEY, USING TRANSMISSIVITY (T) = 200 m²/DAY)



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